Entergy

Annual Radiological Environmental Operating Report

January 1, 2015 - December 31, 2015

Waterford 3 Steam Electric Station
Entergy Operations, Inc.

Docket Number 50-382 **License Number NPF-38**

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Summary

The Annual Radiological Environmental Operating Report presents data obtained through analyses of environmental samples collected for Waterford 3's (W3) Radiological Environmental Monitoring Program (REMP) for the period January 1 through December 31, 2015. This report fulfills the requirements of W3 Technical Specification 6.9.1.7.

During 2015, gross beta radioactivity was detected in air and drinking/surface water locations. Results obtained at the indicator locations were similar to those obtained at the control location. Therefore, levels continue to remain at background.

Radiological Environmental Monitoring Program

W3 established the REMP prior to the station becoming operational (1985) to provide data on background radiation and radioactivity normally present in the area. W3 has continued to monitor the environment by sampling air, water, sediment, milk, fish and broad leaf vegetation, as well as measuring radiation directly.

The REMP includes sampling indicator and control locations within a 31-mile radius of the plant. The REMP utilizes indicator locations near the site to show any increases or buildup of radioactivity that might occur due to station operation, and control locations farther away from the site to indicate the presence of only naturally occurring radioactivity. W3 compares indicator results with control, preoperational, and previous years operational results to assess any impact W3 might have on the surrounding environment.

In 2015, W3 collected environmental samples for radiological analysis. Based on the comparison results of indicator locations with control locations and previous studies, it was concluded that overall W3 operations had no significant impact on plant environs. The review of 2015 data, in many cases, showed undetectable radiation levels in the environment and near background levels in significant pathways associated with W3.

Harmful Effects or Irreversible Damage

The REMP did not detect any harmful effects or evidence of irreversible damage in 2015. Therefore, no analysis or planned course of action to alleviate problems was necessary.

Reporting Levels

W3's review indicates that no samples equaled or exceeded reporting levels for radioactivity concentration in environmental samples, as outlined in Technical Requirements Manual (TRM) Table 3.12-2 when averaged over any calendar quarter, due to W3 effluents. Therefore, 2015 results did not trigger any radiological monitoring program special reports.

Radioactivity Not Attributable to W3

The W3 REMP detected radioactivity attributable to other sources three times. These include the 25th Chinese nuclear test explosion in 1980, the radioactivity plume release due to reactor core degradation at the Chernobyl Nuclear Power Plant in 1986, and the airborne release from Dai-ichi, Fukushima following the Tohoku earthquake on March 11, 2011.

Comparison to State Program

W3 compared REMP data to the monitoring program of the Environmental Radiological Laboratory – Department of Environmental Quality Laboratory Services Division (ERL-DEQLSD). The ERL-DEQLSD and the W3 REMP entail similar radiological environmental monitoring program requirements. Both programs have obtained similar results over previous years.

Sample Deviations

- **Milk Samples**

  Since milk samples for indicator location MKE-3 were unavailable for all quarters of 2015, broad leaf vegetation sampling was performed as required by TRM Table 3.12-1. Broad leaf vegetation results are in section 2.7. Milk samples were collected from one control location and analyzed for Iodine-131 and gamma radionuclides. Results indicate that all measurements were below the calculated LLDs. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2015.

- **Air Samples**

  The air sample locations listed below failed to meet the requirement for sample continuity. As described in footnote (1) of TRM Table 3.12-1, deviations are permitted from the required sampling schedule due to malfunction of sampling equipment and other legitimate reasons.

Location	Sample Period	Explanation of Deviation
APP-1	02/02/15 – 02/16/15	Sample pump tripped
APE-30	04/27/15 – 05/11/15	Sample pump running at low capacity

Attachments

Attachment 1 contains results of air, TLD, water, sediment, milk, fish and broad leaf vegetation collected in 2015. TLDs were analyzed by Stanford Dosimetry. All remaining samples were analyzed by Teledyne Brown Engineering, Inc. Attachment 1 also contains Teledyne's participation in the interlaboratory comparison program during 2015.

Attachment 2 contains statistical comparisons of:

- TLD measurements from stations grouped by distance
- TLD radiation dose to historical data by location
- Gross beta activity measurements on air particulate filters
- Gross beta activity measurements in surface/drinking water samples

1.0 Introduction

1.1 Radiological Environmental Monitoring Program

W3 established the REMP to ensure that plant operating controls properly function to minimize any associated radiation endangerment to human health or the environment. The REMP is designed for:

- Analyzing important pathways for anticipated types and quantities of radionuclides released into the environment.
- Considering the possibility of a buildup of long-lived radionuclides in the environment and identifying physical and biological accumulations that may contribute to human exposures.
- Considering the potential radiation exposure to plant and animal life in the environment surrounding W3.
- Correlating levels of radiation and radioactivity in the environment with radioactive releases from station operation.

1.2 Pathways Monitored

The airborne, direct radiation, waterborne and ingestion pathways are monitored as required by W3 TRM Table 3.12-1. A description of the W3 REMP utilized to monitor the exposure pathways is described in Table 1.1 and shown in Figures 1-1, 1-2 and 1-3.

Section 2.0 of this report provides a discussion of 2015 sampling results with Section 3.0 providing a summary of results for the monitored exposure pathways.

1.3 Land Use Census

W3 conducts a land use census biennially, as required by Section 3.12.2 of the TRM. The purpose of this census is to identify changes in uses of land within five miles of W3 that would require modifications to the REMP and the Offsite Dose Calculation Manual (ODCM). The most important criteria during this census are to determine the location in each sector of the nearest:

1) Residence
2) Animal milked for human consumption
3) Garden of greater than 50 m^2 (500 ft^2) producing broad leaf vegetation.

W3 conducts the land use census by:

- Field surveys in each meteorological sector out to five miles in order to confirm:
  - Nearest permanent residence
  - Nearest garden and approximate size
  - Nearest beef cow
  - Nearest food product
  - Nearest milking animal
- Identifying locations on maps, measuring distances to W3 and recording results on data sheets.
- Comparing current census results to previous results.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Airborne	**Radioiodine and Particulates** Three samples from close to the three SITE BOUNDARY locations, in different sectors, in or near sectors having the highest calculated annual average ground level D/Q.	**APQ-1 (NW, 0.81 Miles)** – (West bank) Located in soybean/sugarcane field off LA 18 east of LA 18/3141 intersection. **APF-1 (ESE, 0.35 Miles)** – (West bank) Located on north side of Secondary Meteorological Tower. **APC-1 (NE, 0.67 Miles)** – (East bank) Located inside Little Gypsy Cooling Water Intake Structure fence.	Continuous sampler operation with sample collection bi-weekly, or more frequently if required by dust loading.	Radioiodine Canister – I-131 analysis bi-weekly. Particulate Sampler – Gross beta radioactivity analysis following filter change. Gamma isotopic analysis of composite (by location) quarterly.
	Radioiodine and Particulates One sample from the vicinity of a community having the highest calculated annual average ground level D/Q.	**APP-1 (WNW, 0.84 Miles)** – (West bank) Located in soybean/sugarcane field on Short St. in Killona.		
	Radioiodine and Particulates One sample from a control location, as for example 15 -30 km distant and in the least prevalent wind direction.	**APE-30 (E, 25.2 Miles)** – (West bank) Located on roof of Entergy Office building on Delaronde St. in Algiers. (Control)		

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.	**A-2 (N, 1.27 Miles)** – (East bank) Located on pole on LA 628 at Zephrin L. Perriloux Fire House. **B-1 (NNE, 0.75 Miles)** – (East bank) Located on fence west of Little Gypsy. **C-1 (NE, 0.67 Miles)** – (East bank) Located on fence at Little Gypsy Cooling Water Intake structure. **D-2 (ENE, 1.24 Miles)** – (East bank) Located on pole on levee at west entrance to Bonnet Carre Spillway.	Quarterly	Gamma dose quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.	**E-1 (E, 0.41 Miles)** – (West bank) Located on pole on LA 18 east of Waterford 3 plant entrance. **F-2 (ESE, 1.15 Miles)** – (West bank) Located on fence on LA 3142 south of LA 18. **G-2 (SE, 1.26 Miles)** – (West bank) Located on fence on LA 3142 north of railroad overpass. **H-2 (SSE, 1.54 Miles)** – (West bank) Located on fence on LA 3142 north of LA 3127/3142 intersection.	Quarterly	Gamma dose quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.	**J-2 (S, 1.38 Miles)** – (West bank) Located on fence south of LA 3127 west of LA 3127/3142 intersection. **K-1 (SSW, 1.06 Miles)** – (West bank) Located on stop sign at entrance to Entergy Education Center on LA 3127. **L-1 (SW, 1.06 Miles)** – (West bank) Located on gate on LA 3127 west of LA 3127/3142 intersection. **M-1 (WSW, 0.76 Miles)** – (West bank) Located on south gate of Waterford 1 and 2. **N-1 (W, 0.98 Miles)** – (West bank) Located on pole at corner of Railroad Avenue and School House Road.	Quarterly	Gamma dose quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.	**P-1 (WNW, 0.84 Miles)** – (West bank) Located on fence enclosing air sample station APP-1. **Q-1 (NW, 0.81 Miles)** – (West bank) Located on fence enclosing air sample station APQ-1. **R-1 (NNW, 0.51 Miles)** – (West bank) Located at Waterford 1 and 2 Cooling Water Intake Structure.	Quarterly	Gamma dose quarterly.
	TLDs An outer ring of stations, 1 in 10 of the meteorological sectors in the 6 to 8 km ranges from the site.	**A-5 (N, 4.59 Miles)** – (East bank) Located on pole at intersection of Oswald Avenue and US 61.		

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An outer ring of stations, 1 in 10 of the meteorological sectors in the 6 to 8 km ranges from the site.	**B-4 (NNE, 3.75 Miles)** – (East bank) Located on pole near weigh station on US 61. **D-5 (ENE, 4.09 Miles)** – (East bank) Located on gate on shell road north of US61/LA48 intersection. **F-4 (ESE, 3.53 Miles)** – (West bank) Located on pole behind house at 646 Aquarius St. in Hahnville.	Quarterly	Gamma dose quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An outer ring of stations, 1 in 10 of the meteorological sectors in the 6 to 8 km ranges from the site.	**E-5 (E, 4.08 Miles)** – (East bank) Located on fence on Wesco Street off LA 48. **G-4 (SE, 3.30 Miles)** – (West bank) Located on pole on LA 3160 north of railroad track. **H-8 (SSE, 8.13 Miles)** – (West bank) Located on pole in front of Hahnville High School. **P-6 (WNW, 5.58 Miles)** – (West bank) Located on fence at LA 640/railroad track intersection. **Q-5 (NW, 5.01 Miles)** – (West bank) Located on pole on LA 18 across from Mississippi River marker 137.	Quarterly	Gamma dose quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An outer ring of stations, 1 in 10 of the meteorological sectors in the 6 to 8 km ranges from the site.	**R-6 (NNW, 5.52 Miles)** – (East bank) Located on fence on LA 3223 near railroad crossing.	Quarterly	Gamma dose quarterly.
	TLDs The balance of the stations to be in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control stations.	**F-9 (ESE, 8.18 Miles)** – (East bank) Located on fence north of railroad tracks on Jonathan Street. **G-8 (SE, 7.74 Miles)** – (West bank) Located on back fence of Luling Entergy Office. **E-15 (E, 11.7 Miles)** – (East bank) Located on fence on Alliance Avenue.		

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** The balance of the stations to be in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control stations.	**J-15 (S, 11.7 Miles)** - (West bank) Located on pole near LA 631/Hwy 90 intersection in Des Allemands. **E-30 (E, 25.2 Miles)** - (West bank) Located at entrance to Entergy office on Delaronde St. in Algiers. (Control)	Quarterly	Gamma dose quarterly.
Waterborne	**Surface Water** One sample upstream One sample downstream	**SWP-7 (WNW, 7.37 Miles)** - (West bank) Located at St. John Parish Waterworks in Edgard. (Control) **SWF-2 (ESE, 1.51 Miles)** - (West bank) Located at Dow Chemical Plant drinking water canal. **SWE-5 (E, 4.59 Miles)** - (East bank) Located at St. Charles Parish Waterworks in New Sarpy. **SWK-1 (SSW, 0.49 Miles)** - (West bank) Located at 40 Arpent Canal south of the plant.	Composite sample over one quarter period.	Gamma isotopic analysis quarterly. Composite for tritium analysis quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Waterborne	**Drinking Water** One sample upstream One sample downstream	**DWP-7 (WNW, 7.37 Miles)** - (West bank) Located at St. John Parish Waterworks in Edgard. (Control) **DWF-2 (ESE, 1.51 Miles)** - (West bank) Located at Dow Chemical Plant drinking water canal. **DWE-5 (E, 4.59 Miles)** - (East bank) Located at St. Charles Parish Waterworks in New Sarpy.	Composite sample over one month period when I-131 analysis is performed, quarterly composite otherwise.	I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than one mrem per year. Composite for gross beta and gamma isotopic analyses quarterly. Composite for tritium analysis quarterly.
	Sediment from Shoreline One sample upstream One sample downstream	**SHWQ-6 (NW, 5.99 Miles)** – (East bank) Located on LA 628 east of Reserve ferry landing. (Control) **SHWE-3 (E, 2.99 Miles)** – (West bank) Located at Foot Ferry landing on LA 18. **SHWK-1 (SSW, 0.49 Miles)** – (West bank) Located at 40 Arpent Canal south of plant.	Annually	Gamma isotopic analysis annually.
Ingestion	**Milk** Samples from milking animals in the three locations within 5 km distance having the highest dose potential. If there are none, then, one sample from milking animals in each of the three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per year.	**MKE-3 (E, 2.35 Miles) -** (West bank) Located at the Zeringue's house on LA 18 in Taft.	Quarterly	Gamma isotopic and I-131 analysis quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Ingestion	Milk One sample from milking animals at a control location 15 – 30 km distant and in the least prevalent wind direction.	**MKA-31 (N, 31.2 Miles)** – (East bank) Located at 18736 Sisters Road, Ponchatoula, LA. (Control)	Quarterly	Gamma isotopic and I-131 analysis quarterly.
	Fish and Invertebrates One sample of each commercially and recreational important species in vicinity of plant discharge area. One sample of same species in area not influenced by plant discharge.	- **FH-2 (Distance/Direction Not Applicable)** – Downstream of the plant discharge structure. **FH-3 (Distance/Direction Not Applicable)** – (Westbank) Waterways downstream of plant discharge directed to 40 Arpent Canal. **FH-1 (Distance/Direction Not Applicable)** – Upstream of the plant intake structure. (Control)	Sample in season, or annually if they are not seasonal	Gamma isotopic analysis on edible portion.
	Broadleaf Samples of one to three different kinds of broadleaf vegetation grown nearest each of two different off-site locations of highest predicted annual average ground level D/Q if milk sampling is not performed. One sample of each of the similar broadleaf vegetation grown 15 – 30 km distant in the least prevalent wind direction if milk sampling is not performed.	**BLQ-1 (NW, 0.83 Miles)** – (West bank) Located near air sample station APQ-1. **BLB-1 (NNE, 0.81 Miles)** – (East bank) Located west of Little Gypsy on LA 628. **BLE-20 (E, 19.7 Miles)** – (West bank) Located on property of Nine Mile Point in Westwego. (Control)	Quarterly	Gamma isotopic and I-131 analysis.

FIGURE 1-1

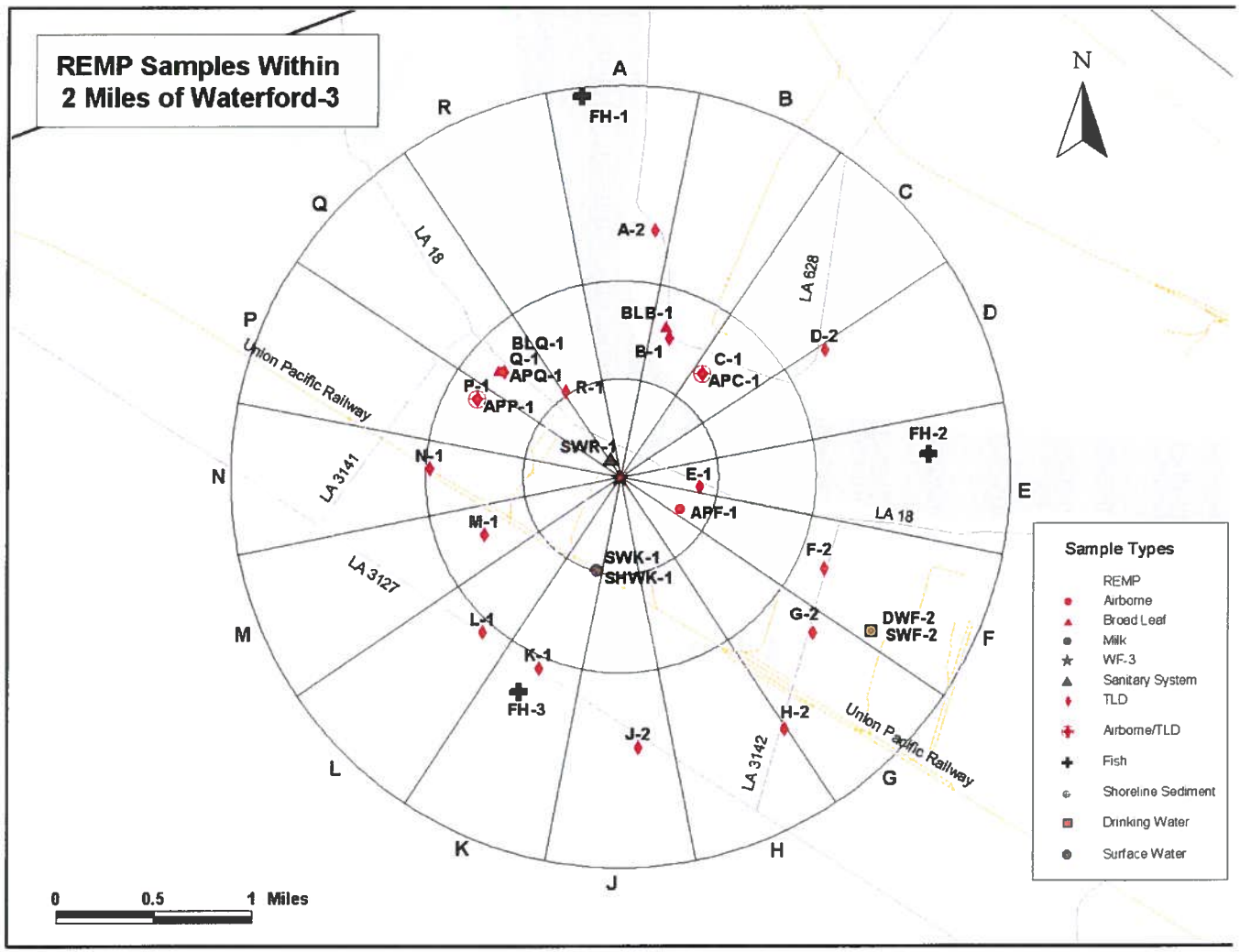

REMP Samples Within
2 Miles of Waterford-3
N
A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q
R
FH-1
A-2
BLB-1
B-1
C-1
APC-1
D-2
FH-2
E-1
APF-1
F-2
G-2
DWF-2
SWF-2
H-2
J-2
FH-3
K-1
L-1
M-1
N-1
SWK-1
SHWK-1
SWR-1
P-1
APP-1
R-1
BLQ-1
Q-1
APQ-1
LA 18
LA 828
LA 3141
LA 3127
LA 3142
Union Pacific Railway
Sample Types
REMP
Airborne
Broad Leaf
Milk
WF-3
Sanitary System
TLD
Airborne/TLD
Fish
Shoreline Sediment
Drinking Water
Surface Water
0
0.5
1 Miles

FIGURE 1-2

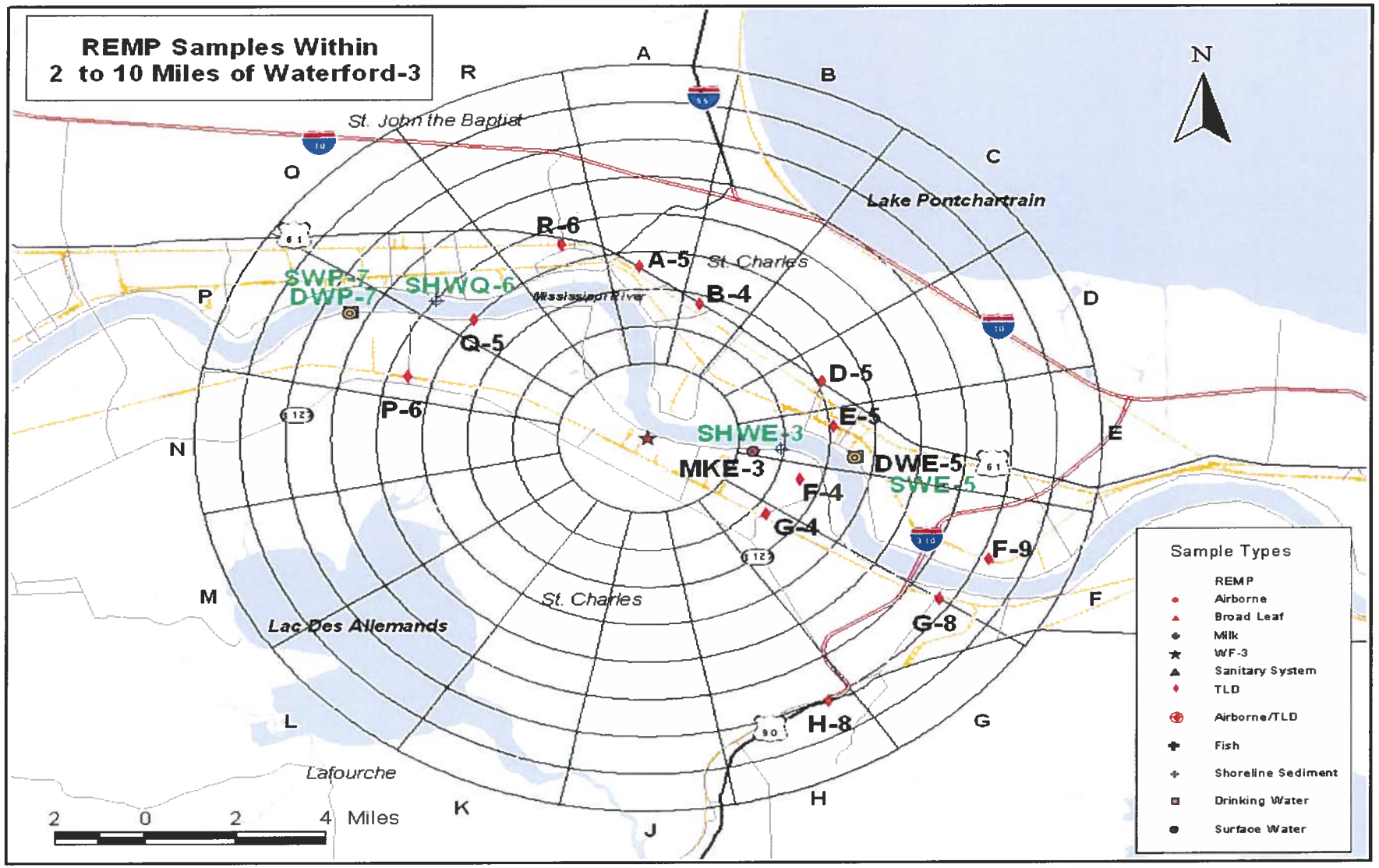
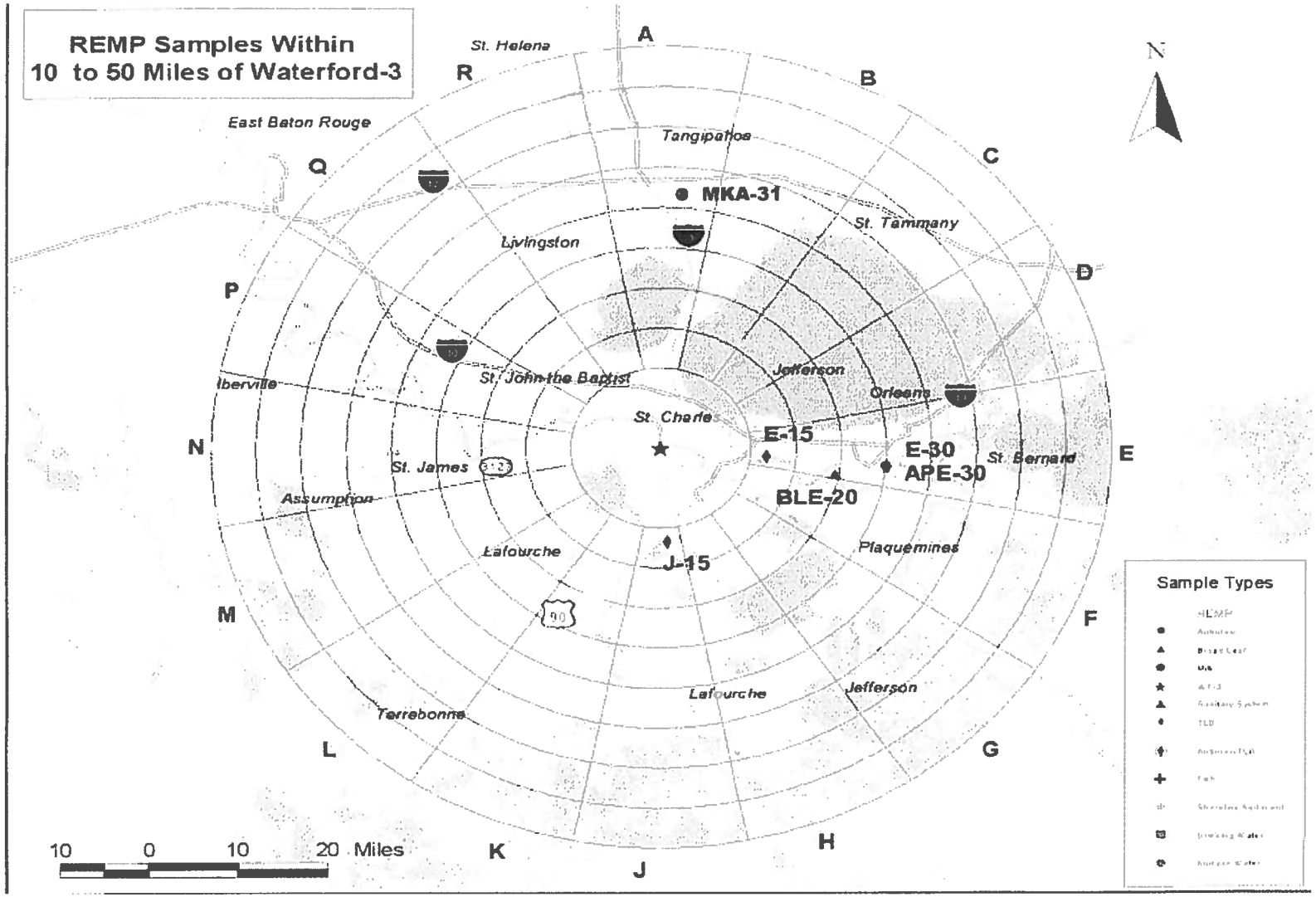

REMP Samples Within
2 to 10 Miles of Waterford-3
N
A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q
R
St. John the Baptist
Lake Pontchartrain
St. Charles
Mississippi River
Lac Des Allemands
Lafourche
R-6
A-5
B-4
SWP-7
DWP-7
SHWQ-6
Q-5
P-6
D-5
E-5
SHWE-3
MKE-3
DWE-5
SWE-5
F-4
G-4
F-9
G-8
H-8
2 0 2 4 Miles
Sample Types
REMP
Airborne
Broad Leaf
Milk
WF-3
Sanitary System
TLD
Airborne/TLD
Fish
Shoreline Sediment
Drinking Water
Surface Water

FIGURE 1-3


REMP Samples Within
10 to 50 Miles of Waterford-3
N
A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q
R
St. Helena
East Baton Rouge
Tangipahoa
MKA-31
St. Tammany
Livingston
St. John the Baptist
Jefferson
Orleans
St. Charles
E-15
E-30
APE-30
St. Bernard
St. James
BLE-20
Assumption
Lafourche
J-15
Plaquemines
Terrebonne
Lafourche
Jefferson
10 0 10 20 Miles
Sample Types

2.0 Interpretation and Trends of Results

2.1 Air Particulate and Radioiodine Sample Results

Samples of airborne particulate and radioiodine were collected at four indicator locations and one control location and analyzed for gross beta radionuclides, Iodine-131 and gamma radionuclides (quarterly air particulate filter composites only). W3 did not detect any gamma radionuclides in the quarterly air particulate composites or Iodine-131 in the radioiodine cartridges during the reporting period as has been the case in previous years. Indicator gross beta air particulate results for 2015 were similar to those background levels obtained in previous years of the operational REMP and well below preoperational levels as seen below. Results are reported as annual average pCi/m^3.

Monitoring Period	Result
Preoperational	0.080
1983 – 2014	0.020
2015	0.018

Table 3.1, which includes gross beta concentrations for 2015, provides a comparison of the indicator and control means. It further emphasizes that the airborne pathway continues to remain at background levels. In addition, as shown in Attachment 2, the standard "t" test was used to compare average gross beta activity from each indicator station to the average gross beta activity at the control station. The results from this test show the average activity detected at all indicator stations is statistically the same as the average activity detected at the control station. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2015.

2.2 Thermoluminescent Dosimetry Sample Results

The average exposure rates during 2015 are consistent with those from the preoperational program and the previous five years of operation as seen in Figure 2-1. In particular, the preoperational survey indicates that exposure rates ranged between 11 and 33 mrem/standard quarter with an average of 20 mrem/standard quarter. The range during the previous five years of operation was 9 to 16 mrem/standard quarter with an average exposure rate of 12 mrem/standard quarter.

A comparison of the indicator results to the control results, as seen in Table 3.1, shows that the average indicator is slightly higher than that of the control. As shown in Attachment 1, Table 2.1, several indicator locations are higher than the control by a few mrem with a maximum difference of six mrem.

As shown in Attachment 2, Table 2.1, the standard "t" test was used to compare average exposure rates for TLD stations located in groups 0-2 miles and 2-5 miles from the plant to those > 5 miles. The results indicate that the average exposure rates 0-2 miles from the plant are statistically the same as >5 miles while those 2-5 miles are statistically higher.

The differences between indicator locations and the control, and TLD stations grouped by distance from the plant are expected due to a variety of factors not related to W3 plant operations that can affect background radiation in the vicinity of each TLD station. Direct radiation measurements at each TLD station have remained statistically the same in 2015 as previous years of operation as evidenced on Attachment 2, Table 2.2. In addition, Radiological Gaseous Effluents for 2015 were only a small fraction of the limits and are not expected to have any impact on environmental TLD measurements.

2.3 Water Sample Results

Analytical results for 2015 drinking/surface water samples were similar to those reported in previous years.

Drinking/Surface Water

Drinking water samples also serve as surface water samples for W3. Therefore, monthly and quarterly gamma spectroscopy and tritium analyses of drinking water also satisfy the surface water sampling requirement.

Composite drinking/surface water samples were collected from two indicators and one control location and analyzed for Iodine-131, gamma radionuclides and tritium. Results indicate that all measurements were below the calculated LLDs.

Although gross beta was detected in the drinking/surface water samples, results for the indicator locations were below preoperational years and slightly above previous operational years as seen below. Results are reported as annual average pCi/l.

Monitoring Period	Result
Preoperational	7.0
1983 – 2014	4.7
2015	5.7

Table 3.1, which includes gross beta concentrations for 2015, provides a comparison of the indicator and control means. It shows that the waterborne pathway continues to remain at background levels. In addition, as shown in Attachment 2, the standard "t" test was used to compare average gross beta activity from indicator stations to the average gross beta activity from the control station. The results from the test show the average activity detected at one indicator station is statistically the same as the average activity detected at the control station and one indicator station is statistically higher than the mean for the control location. Results are consistent with historical data stated above. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2015.

Surface Water

Surface water samples were collected from one indicator location and analyzed for gamma radionuclides and tritium. Results indicate that all measurements were below the calculated LLDs. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2015.

2.4 Sediment Sample Results

Sediment samples were collected from two indicator locations and one control location and analyzed for gamma radionuclides. Results indicate that all measurements were below the calculated LLDs. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2015.

2.5 Milk Sample Results

Since milk samples for indicator location MKE-3 were unavailable for all quarters of 2015, broad leaf vegetation sampling was performed as required by TRM Table 3.12-1. Broad leaf vegetation results are in section 2.7. Milk samples were collected from one control location and analyzed for Iodine-131 and gamma radionuclides. Results indicate that all measurements were below the calculated LLDs. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2015.

2.6 Fish Sample Results

Fish samples were collected from two indicators and one control location and analyzed for gamma radionuclides. Results indicate that all measurements were below the calculated LLDs. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2015.

2.7 Broadleaf Vegetation Sample Results

Broadleaf vegetation samples were collected from two indicators and one control location and analyzed for Iodine-131 and gamma radionuclides. Results indicate that all measurements were below the calculated LLDs. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2015.

2.8 Land Use Census Results

In compliance with the Waterford 3 ODCM and TRM, the land use census was conducted September 22 – September 24, 2014. The nearest residence, garden, beef cow, food product and milk animal in each sector within a five mile radius of the plant was located by visual inspection and verbal inquiry.

Two new garden locations (sectors P and Q) were identified in 2014. Residence, milk cow, and goat locations remained unchanged for 2014. Beef cows located in sector E at a distance of 2.9 miles from the plant have been removed. A soybean field is located in sector N at a distance of 0.6 miles from the plant. Based upon the locations identified in this survey, the locations identified in previous surveys and the locations currently being used to calculate dose commitments from liquid and gaseous effluents released from W3, no REMP sampling location changes are necessary. Results of the 2014 biennial census are shown in Table 2.1.

2.9 Interlaboratory Comparison Results

Teledyne Brown Engineering, Inc. analyzed interlaboratory comparison samples for W3 to fulfill the requirements of Section 5.7.2 of the ODCM. Attachment 1 contains these results.

TABLE 2.1

Biennial Land Use Census Results

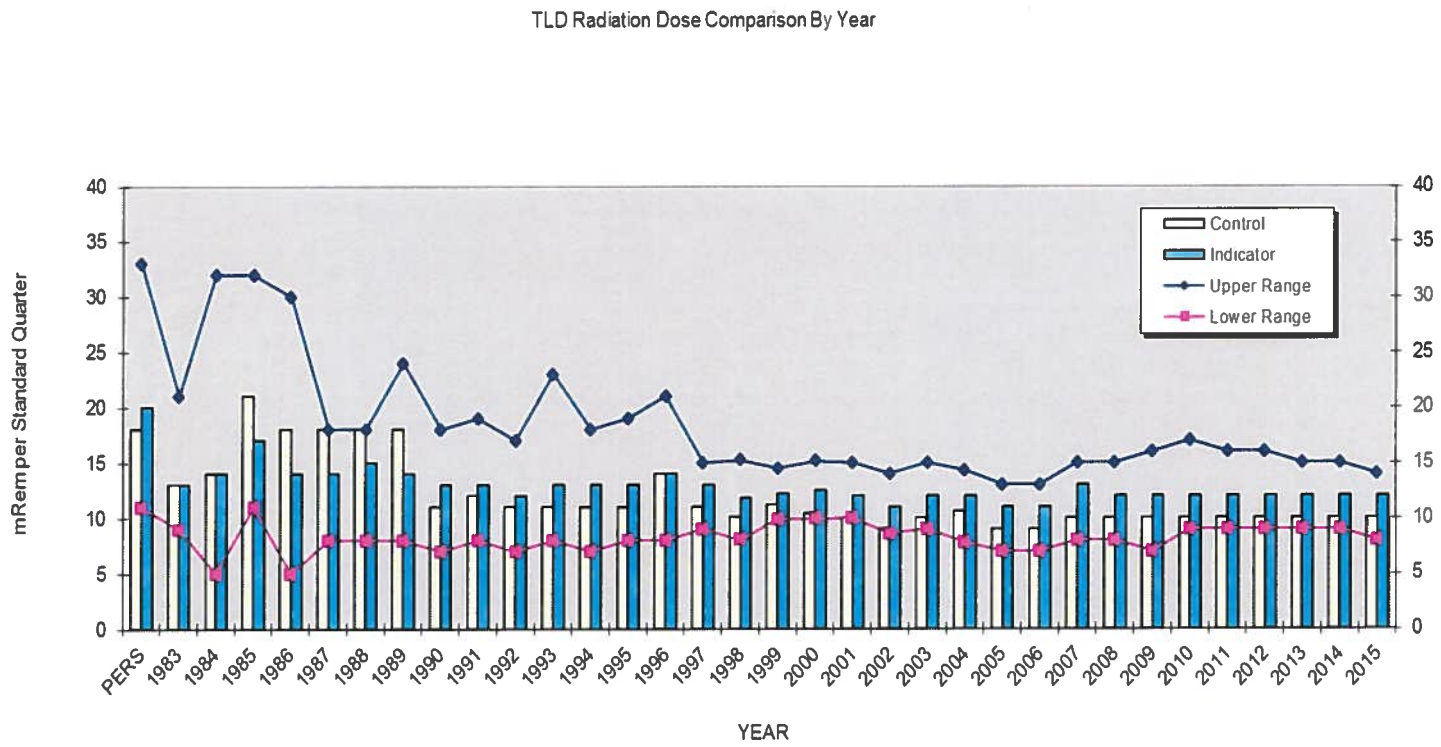
Sector	Direction	Distance from Plant in Miles					
		Residence	Garden	Milk Cows	Beef Cows	Goats	Food Products
A	*N*	1.3	1.7	^	4.8	^	4.1
B	*NNE*	1.1	1.3	^	^	^	1.3
C	*NE*	0.9	1.0	^	^	^	^
D	*ENE*	0.9	3.2	^	^	^	^
E	*E*	2.2	2.2	**2.3	2.3	* 3.2	0.3
F	*ESE*	3.1	2.2	^	2.3	^	0.3
G	*SE*	4.0	4.1	^	2.4	^	0.3
H	*SSE*	^	^	^	^	^	0.3
J	*S*	^	^	^	^	^	0.5
K	*SSW*	^	^	^	^	^	0.5
L	*SW*	^	^	^	^	^	0.5
M	*WSW*	^	1.4	^	1.2	^	0.5
N	*W*	1.0	1.1	^	1.0	^	0.6
P	*WNW*	0.9	0.9	^	^	^	0.6
Q	*NW*	0.9	0.8	^	^	^	0.6
R	*NNW*	3.0	3.0	^	4.9	^	2.6

^ Indicates that nothing was found in the sector within a five mile radius of Waterford 3

* Animals were located at this distance from Waterford 3, but the milk is not currently used for human consumption

** Samples are being obtained from animals at this location (MKE-3) for REMP

FIGURE 2-1


TLD Radiation Dose Comparison By Year
mRem per Standard Quarter
YEAR
Control
Indicator
Upper Range
Lower Range
0
5
10
15
20
25
30
35
40
PERS
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

3.0 Radiological Environmental Monitoring Program Summary

3.1 2015 Program Results Summary

Table 3.1 summarizes the 2015 REMP results. W3 did not use values reported as less than the lower limit of detection (< LLD) when determining ranges and means for indicator and control locations.

TABLE 3.1

Radiological Environmental Monitoring Program Summary

Name of Facility: Waterford 3 SES Docket No: 50-382
Location of Facility: St. Charles, Louisiana Reporting Period: January - December 2015

Sample Type (Units)	Type & Number Of Analyses [a]	LLD [b]	Indicator Locations Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Airborne Particulates (pCi/m^3)	GB 130	0.01	0.018 (103 / 104) [0.010 - 0.029]	APF-1 (ESE, 0.35 mi.)	0.019 (26 / 26) [0.011 - 0.029]	0.019 (25 / 26) [0.006 - 0.027]	0
	GS 20						
	Cs-134	0.05	<LLD	N/A	N/A	<LLD	0
	Cs-137	0.06	<LLD	N/A	N/A	<LLD	0
Airborne Iodine (pCi/m^3)	I-131 130	0.07	<LLD	N/A	N/A	<LLD	0
Indicator TLDs (mrem/Std. Qtr)	Gamma 120	(f)	12 (111 / 120) [8.2 – 14.5]	F-4 (ESE, 3.53 mi.)	14 (4 / 4) [13.9 – 14.5]	N/A	0
Control TLDs (mrem/Std. Qtr)	Gamma 4	(f)	N/A	N/A	N/A	10 (4 / 4) [8.6 – 10.6]	0

TABLE 3.1

Radiological Environmental Monitoring Program Summary

Name of Facility: Waterford 3 SES Docket No: 50-382
Location of Facility: St. Charles, Louisiana Reporting Period: January - December 2015

Sample Type (Units)	Type & Number of Analyses [a]	LLD [b]	Indicator Location Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Surface Water & Drinking Water (pCi/l)	Gross Beta 12	4	5.7 (8 / 8) [3.8 – 8.1]	DWF/SWF-2 (ESE, 1.51 mi.)	7.2 (4 / 4) [6.1 – 8.1]	4.7 (4 / 4) [2.7 – 5.6]	0
	I-131 40	1	<LLD	N/A	N/A	<LLD	0
	H-3 12	2000	<LLD	N/A	N/A	<LLD	0
	GS 12						
	Mn-54	15	<LLD	N/A	N/A	<LLD	0
	Fe-59	30	<LLD	N/A	N/A	<LLD	0
	Co-58	15	<LLD	N/A	N/A	<LLD	0
	Co-60	15	<LLD	N/A	N/A	<LLD	0
	Zn-65	30	<LLD	N/A	N/A	<LLD	0
	Zr-95	15	<LLD	N/A	N/A	<LLD	0
	Nb-95	15	<LLD	N/A	N/A	<LLD	0
	Cs-134	15	<LLD	N/A	N/A	<LLD	0
	Cs-137	18	<LLD	N/A	N/A	<LLD	0
	Ba-140	15	<LLD	N/A	N/A	<LLD	0
	La-140	15	<LLD	N/A	N/A	<LLD	0

TABLE 3.1

Radiological Environmental Monitoring Program Summary

Name of Facility: Waterford 3 SES Docket No: 50-382
Location of Facility: St. Charles, Louisiana Reporting Period: January - December 2015

Sample Type (Units)	Type & Number of Analyses [a]	LLD [b]	Indicator Locations Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Surface Water (pCi/l)	H-3 4	3000	<LLD	N/A	N/A	N/A	0
	GS 13						
	Mn-54	15	<LLD	N/A	N/A	N/A	0
	Fe-59	30	<LLD	N/A	N/A	N/A	0
	Co-58	15	<LLD	N/A	N/A	N/A	0
	Co-60	15	<LLD	N/A	N/A	N/A	0
	Zn-65	30	<LLD	N/A	N/A	N/A	0
	Zr-95	15	<LLD	N/A	N/A	N/A	0
	Nb-95	15	<LLD	N/A	N/A	N/A	0
	Cs-134	15	<LLD	N/A	N/A	N/A	0
	Cs-137	18	<LLD	N/A	N/A	N/A	0
	Ba-140	15	<LLD	N/A	N/A	N/A	0
	La-140	15	<LLD	N/A	N/A	N/A	0
	I-131	15	<LLD	N/A	N/A	N/A	0
Shoreline Sediment (pCi/kg dry)	GS 3						
	Cs-134	150	<LLD	N/A	N/A	<LLD	0
	Cs-137	180	<LLD	N/A	N/A	<LLD	0

TABLE 3.1
Radiological Environmental Monitoring Program Summary

Name of Facility: Waterford 3 SES Docket No: 50-382
Location of Facility: St. Charles, Louisiana Reporting Period: January - December 2015

Sample Type (Units)	Type & Number of Analyses [a]	LLD [b]	Indicator Location Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Milk (pCi/l)	I-131 4	1	< LLD	N/A	N/A	<LLD	0
	GS 4						
	Cs-134	15	< LLD	N/A	N/A	<LLD	0
	Cs-137	18	< LLD	N/A	N/A	<LLD	0
	Ba-140	15	< LLD	N/A	N/A	<LLD	
	La-140	15	< LLD	N/A	N/A	<LLD	0
							0
Fish (pCi/kg wet)	GS 13						
	Mn-54	130	<LLD	N/A	N/A	<LLD	0
	Fe-59	260	<LLD	N/A	N/A	<LLD	0
	Co-58	130	<LLD	N/A	N/A	<LLD	0
	Co-60	130	<LLD	N/A	N/A	<LLD	0
	Zn-65	260	<LLD	N/A	N/A	<LLD	0
	Cs-134	130	<LLD	N/A	N/A	<LLD	0
	Cs-137	150	<LLD	N/A	N/A	<LLD	0
Broadleaf Vegetation (pCi/kg wet)	I-131 12	60	<LLD	N/A	N/A	<LLD	0
	GS 12						
	Cs-134	60	<LLD	N/A	N/A	<LLD	0
	Cs-137	80	<LLD	N/A	N/A	<LLD	0

a GB = Gross beta; I-131 = Iodine-131; H-3 = Tritium; GS = Gamma scan.
b LLD = required lower limit of detection based on Waterford 3 TRM.
c Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parenthesis (F).
d Locations are specified (1) by name and (2) degrees relative to reactor site.
e Non-routine results are those which exceed ten times the control station value. If no control station value is available, the result is considered non-routine if it exceeds ten times the preoperational value for the location.
f LLD is not defined in Waterford 3 TRM.

Attachment 1

2015 Radiological Monitoring Report

Summary of Monitoring Results

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Table 1.1
Sample Type: **Air Particulate Filter**
Analysis: Gross Beta
Units: pCi/m^3

End Date	APF-1 (Indicator)	APQ-1 (Indicator)	APP-1 (Indicator)	APC-1 (Indicator)	APE-30 (Control)
Required LLD →	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
01-06-15	0.0171	0.0175	0.0169	0.0201	0.0196
01-20-15	0.0229	0.0233	0.0236	0.0264	0.0251
02-02-15	0.0224	0.0194	0.0241	0.0205	0.0258
02-16-15	0.0289	0.0237	(1)	0.0280	0.0272
03-02-15	0.0165	0.0164	0.0173	0.0197	0.0171
03-16-15	0.0113	0.0097	0.0114	0.0103	0.0107
03-30-15	0.0144	0.0117	0.0144	0.0098	0.0134
04-13-15	0.0146	0.0117	0.0151	0.0122	0.0128
04-27-15	0.0126	0.0146	0.0147	0.0124	0.0059
05-11-15	0.0184	0.0186	0.0201	0.0201	(2)
05-26-15	0.0152	0.0148	0.0136	0.0138	0.0195
06-08-15	0.0213	0.0179	0.0208	0.0195	0.0257
06-22-15	0.0189	0.0166	0.0144	0.0145	0.0213
07-07-15	0.0186	0.0166	0.0145	0.0155	0.0177
07-20-15	0.0171	0.0153	0.0146	0.0138	0.0169
08-03-15	0.0210	0.0209	0.0190	0.0184	0.0208
08-17-15	0.0201	0.0208	0.0166	0.0178	0.0188
08-31-15	0.0183	0.0149	0.0176	0.0146	0.0180
09-14-15	0.0237	0.0180	0.0156	0.0155	0.0169
09-28-15	0.0273	0.0249	0.0249	0.0243	0.0235
10-12-15	0.0189	0.0161	0.0189	0.0179	0.0176
10-26-15	0.0192	0.0217	0.0145	0.0190	0.0210
11-09-15	0.0157	0.0176	0.0148	0.0164	0.0151
11-22-15	0.0235	0.0231	0.0236	0.0198	0.0235
12-07-15	0.0217	0.0219	0.0203	0.0185	0.0211
12-21-15	0.0228	0.0203	0.0202	0.0211	0.0215

(1) No volume due to sample pump trip
(2) Low volume due to sample pump running at low capacity

Table 1.2
Sample Type: **Radioiodine Cartridge**
Analysis: Iodine-131
Units: pCi/m^3

End Date	APF-1 (Indicator)	APQ-1 (Indicator)	APP-1 (Indicator)	APC-1 (Indicator)	APE-30 (Control)
Required LLD →	**0.07**	**0.07**	**0.07**	**0.07**	**0.07**
01-06-15	< 0.0283	< 0.0257	< 0.0267	< 0.0272	< 0.0113
01-20-15	< 0.0415	< 0.0377	< 0.0391	< 0.0399	< 0.0204
02-02-15	< 0.0099	< 0.0232	< 0.0295	< 0.0246	< 0.0242
02-16-15	< 0.0535	< 0.0484	(1)	< 0.0517	< 0.0508
03-02-15	< 0.0262	< 0.0093	< 0.0312	< 0.0251	< 0.0249
03-16-15	< 0.0166	< 0.0390	< 0.0515	< 0.0413	< 0.0407
03-30-15	< 0.0320	< 0.0113	< 0.0382	< 0.0312	< 0.0301
04-13-15	< 0.0264	< 0.0093	< 0.0304	< 0.0254	< 0.0250
04-27-15	< 0.0331	< 0.0300	< 0.0369	< 0.0133	< 0.0379
05-11-15	< 0.0160	< 0.0267	< 0.0318	< 0.0534	(2)
05-26-15	< 0.0420	< 0.0104	< 0.0300	< 0.0244	< 0.0339
06-08-15	< 0.0238	< 0.0222	< 0.0095	< 0.0207	< 0.0277
06-22-15	< 0.0279	< 0.0263	< 0.0278	< 0.0245	< 0.0136
07-07-15	< 0.0125	< 0.0285	< 0.0293	< 0.0265	< 0.0284
07-20-15	< 0.0135	< 0.0332	< 0.0332	< 0.0298	< 0.0326
08-03-15	< 0.0358	< 0.0343	< 0.0342	< 0.0119	< 0.0336
08-17-15	< 0.0222	< 0.0545	< 0.0543	< 0.0488	< 0.0542
08-31-15	< 0.0230	< 0.0562	< 0.0560	< 0.0503	< 0.0558
09-14-15	< 0.0199	< 0.0449	< 0.0446	< 0.0401	< 0.0445
09-28-15	< 0.0149	< 0.0362	< 0.0361	< 0.0330	< 0.0360
10-12-15	< 0.0383	< 0.0363	< 0.0171	< 0.0413	< 0.0364
10-26-15	< 0.0302	< 0.0111	< 0.0262	< 0.0259	< 0.0287
11-09-15	< 0.0090	< 0.0221	< 0.0200	< 0.0197	< 0.0220
11-22-15	< 0.0164	< 0.0370	< 0.0368	< 0.0331	< 0.0372
12-07-15	< 0.0218	< 0.0494	< 0.0491	< 0.0440	< 0.0491
12-21-15	< 0.0114	< 0.0278	< 0.0276	< 0.0249	< 0.0280

(1) No volume due to sample pump trip
(2) Low volume due to sample pump running at low capacity

Table 1.3
Sample Type: **Air Particulate Filter**
Analysis: Gamma Isotopic
Units: pCi/m^3

Location	Quarterly Composite	Cs-134	Cs-137
	Required LLD →	**0.05**	**0.06**
APF-1 (Indicator)	1st	< 0.003	< 0.003
APQ-1 (Indicator)	1st	< 0.003	< 0.003
APP-1 (Indicator)	1st	< 0.005	< 0.004
APC-1 (Indicator)	1st	< 0.004	< 0.003
APE-30 (Control)	1st	< 0.004	< 0.004
APF-1 (Indicator)	2nd	< 0.004	< 0.004
APQ-1 (Indicator)	2nd	< 0.003	< 0.002
APP-1 (Indicator)	2nd	< 0.005	< 0.004
APC-1 (Indicator)	2nd	< 0.004	< 0.003
APE-30 (Control)	2nd	< 0.005	< 0.004
APF-1 (Indicator)	3rd	< 0.005	< 0.005
APQ-1 (Indicator)	3rd	< 0.003	< 0.002
APP-1 (Indicator)	3rd	< 0.002	< 0.002
APC-1 (Indicator)	3rd	< 0.002	< 0.002
APE-30 (Control)	3rd	< 0.003	< 0.002
APF-1 (Indicator)	4th	< 0.003	< 0.003
APQ-1 (Indicator)	4th	< 0.002	< 0.002
APP-1 (Indicator)	4th	< 0.004	< 0.003
APC-1 (Indicator)	4th	< 0.002	< 0.002
APE-30 (Control)	4th	< 0.003	< 0.002

Table 2.1
Sample Type: **Thermoluminescent Dosimeters**
Analysis: Gamma Dose
Units: mrem/Std. Qtr.

Indicator Locations

Station	1st Qtr '15	2nd Qtr '15	3rd Qtr '15	4th Qtr '15	Annual Mean '15
A-2	13	12	14	13	13
A-5	13	12	13	13	12
B-1	13	12	13	14	13
B-4	13	12	14	14	13
C-1	9	8	9	10	9
D-2	13	11	12	13	12
D-5	12	11	11	12	11
E-1	11	10	11	11	11
E-5	13	12	13	13	13
E-15	11	9	10	10	10
F-2	12	12	12	12	12
(1) F-4	14	14	14	14	14
F-9	12	13	(2)	12	12
G-2	11	11	11	12	11
G-4	11	(2)	11	11	11
G-8	11	11	(2)	(2)	11
H-2	11	10	11	10	10
H-8	14	(2)	11	(2)	12
J-2	11	10	10	10	10
J-15	13	13	13	13	13
K-1	(2)	10	11	11	10
L-1	14	14	14	13	14
M-1	10	10	10	10	10
N-1	(2)	11	10	11	11
P-1	9	10	9	10	9
P-6	13	13	13	13	13
Q-1	13	12	12	12	12
Q-5	13	(2)	13	13	13
R-1	9	9	9	10	9
R-6	10	10	10	10	10

Control Location

Station	1st Qtr '15	2nd Qtr '15	3rd Qtr '15	4th Qtr '15	Annual Mean '15
E-30	10	9	10	11	10

(1) Location with highest annual mean
(2) No data - TLDs missing at time of exchange

Table 3.1
Sample Type: **Drinking/Surface Water**
Analysis: Gross Beta
Units: pCi/l

Quarterly Composite	DWF/SWF-2 (Indicator)	DWE/SWE-5 (Indicator)	DWP/SWP-7 (Control)
Required LLD →	4	4	4
1st	6.89	3.77	4.73
2nd	6.05	4.26	5.54
3rd	7.53	5.15	5.63
4th	8.13	4.10	2.71

Table 3.2
Sample Type: **Drinking/Surface Water**
Analysis: Iodine-131
Units: pCi/l

Collection Date	SWK-1 (Indicator)	DWF/SWF-2 (Indicator)	DWE/SWE-5 (Indicator)	DWP/SWP-7 (Control)
LLD	15	1	1	1
01-27-15[1]			< 0.49	
01-27-15	< 3.91	< 0.47	< 0.40	< 0.49
02-24-15	< 5.49	< 0.55	< 0.67	< 0.71
03-24-15	< 3.52	< 0.53	< 0.50	< 0.57
04-21-15	< 1.70	< 0.58	< 0.70	< 0.75
05-19-15	< 4.75	< 0.33	< 0.42	< 0.40
06-16-15	< 3.76	< 0.29	< 0.82	< 0.35
07-13-15	< 3.87	< 0.40	< 0.39	< 0.52
08-11-15	< 6.08	< 0.77	< 0.72	< 0.80
09-08-15	< 3.98	< 0.44	< 0.46	< 0.51
10-06-15	< 4.98	< 0.40	< 0.51	< 0.38
11-03-15	< 4.81	< 0.68	< 0.76	< 0.89
12-01-15	< 3.73	< 0.75	< 0.74	< 0.82
12-29-15	< 6.07	< 0.43	< 0.41	< 0.52

[1] Duplicate sample

Table 3.3
Sample Type: **Drinking/Surface Water**
Analysis: Gamma Isotopic
Units: pCi/l

Location	Collection Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
Required LLD	→	**15**	**15**	**30**	**15**	**30**	**15**	**15**	**15**	**18**	**15**	**15**
DWF/SWF-2 (Indicator)	1st	< 1.78	< 1.77	< 3.81	< 1.73	< 3.68	< 1.93	< 3.32	< 1.73	< 1.92	< 9.83	< 2.91
DWE/SWE-5 (Indicator)	1st	< 1.77	< 1.96	< 3.91	< 1.70	< 3.74	< 1.96	< 3.51	< 1.83	< 2.03	< 10.20	< 2.93
DWP/SWP-7 (Control)	1st	< 1.19	< 1.27	< 2.60	< 1.11	< 2.33	< 1.37	< 2.40	< 1.22	< 1.33	< 7.52	< 2.09
DWF/SWF-2 (Indicator)	2nd	< 1.63	< 1.69	< 3.87	< 1.68	< 3.73	< 1.78	< 2.99	< 1.58	< 1.76	< 8.95	< 2.87
DWE/SWE-5 (Indicator)	2nd	< 2.04	< 1.93	< 4.45	< 1.99	< 3.98	< 2.12	< 3.62	< 1.99	< 2.23	< 11.40	< 3.57
DWP/SWP-7 (Control)	2nd	< 1.59	< 1.46	< 3.48	< 1.71	< 3.22	< 1.73	< 2.75	< 1.50	< 1.78	< 8.38	< 2.88
DWF/SWF-2 (Indicator)	3rd	< 1.76	< 1.88	< 3.94	< 2.12	< 3.70	< 1.95	< 3.18	< 1.65	< 1.87	< 8.53	< 2.70
DWE/SWE-5 (Indicator)	3rd	< 2.32	< 2.43	< 5.42	< 2.57	< 4.32	< 2.35	< 4.39	< 2.16	< 2.40	< 10.70	< 3.50
DWP/SWP-7 (Control)	3rd	< 1.95	< 1.89	< 3.98	< 2.17	< 3.86	< 2.07	< 3.42	< 1.87	< 2.05	< 9.87	< 3.09
DWF/SWF-2 (Indicator)	4th	< 3.05	< 3.26	< 6.41	< 3.29	< 5.99	< 3.16	< 5.59	< 2.75	< 3.04	< 14.30	< 5.51
DWE/SWE-5 (Indicator)	4th	< 2.63	< 2.96	< 5.34	< 2.37	< 5.42	< 2.68	< 5.24	< 2.47	< 3.00	< 12.70	< 3.61
DWP/SWP-7 (Control)	4th	< 2.53	< 2.68	< 5.70	< 2.94	< 5.14	< 2.55	< 4.88	< 2.53	< 2.77	< 12.70	< 3.61

Table 3.4
Sample Type: **Drinking/Surface Water**
Analysis: Tritium
Units: pCi/l

Quarter	DWF/SWF-2 (Indicator)	DWE/SWE-5 (Indicator)	SWK-1 (Indicator)	DWP/SWP-7 (Control)
Required LLD →	**2000**	**2000**	**3000**	**2000**
1st	< 486	< 468	< 482	< 479
2nd	< 563	< 566	< 569	< 564
3rd	< 699	< 711	< 718	< 719
4th	< 734	< 725	< 724	< 742

Table 3.5
Sample Type: **Surface Water**
Analysis: Gamma Isotopic
Units: pCi/l

Location	Collection Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
Required LLD →		15	15	30	15	30	15	15	15	18	15	15
SWK-1 (Indicator)	01-27-15	< 2.17	< 2.28	< 5.05	< 2.41	< 4.59	< 2.33	< 4.03	< 2.08	< 2.24	< 11.20	< 3.71
	02-24-15	< 2.61	< 2.78	< 5.68	< 2.64	< 4.93	< 2.75	< 5.38	< 2.66	< 3.27	< 14.20	< 4.62
	03-24-15	< 1.78	< 1.74	< 4.03	< 1.97	< 3.81	< 1.94	< 3.28	< 1.69	< 1.83	< 9.19	< 2.92
	04-21-15	< 1.23	< 1.28	< 2.60	< 1.27	< 2.72	< 1.39	< 2.28	< 1.27	< 1.42	< 5.17	< 1.61
	05-19-15	< 2.70	< 2.49	< 4.97	< 2.42	< 4.96	< 2.43	< 4.35	< 2.26	< 2.64	< 12.30	< 4.20
	06-16-15	< 2.85	< 3.06	< 5.56	< 3.13	< 5.46	< 3.02	< 5.42	< 2.98	< 3.14	< 13.30	< 3.51
	07-13-15	< 2.46	< 2.39	< 5.00	< 2.41	< 4.94	< 2.64	< 4.29	< 2.78	< 2.77	< 11.80	< 3.37
	08-11-15	< 3.36	< 2.91	< 5.61	< 3.56	< 5.18	< 3.40	< 5.47	< 2.99	< 3.30	< 14.50	< 4.18
	09-08-15	< 3.05	< 2.61	< 4.93	< 3.22	< 6.23	< 2.79	< 4.77	< 2.85	< 3.66	< 12.40	< 3.71
	10-06-15	< 2.56	< 2.63	< 5.23	< 2.43	< 4.65	< 2.59	< 4.72	< 2.55	< 2.66	< 13.00	< 4.34
	11-03-15	< 3.77	< 3.69	< 7.49	< 4.23	< 6.22	< 3.35	< 6.51	< 3.47	< 3.79	< 13.40	< 5.16
	12-01-15	< 1.75	< 1.82	< 3.84	< 1.80	< 3.57	< 1.93	< 3.31	< 1.74	< 1.93	< 9.14	< 3.29
	12-29-15	< 2.64	< 3.10	< 6.06	< 3.09	< 5.53	< 2.78	< 4.65	< 2.72	< 2.47	< 14.90	< 4.38

Table 4.1
Sample Type: **Sediment**
Analysis: Gamma Isotopic
Units: pCi/kg (dry)

Location	Collection Date	Cs-134	Cs-137
Required LLD	→	**150**	**180**
SHWK-1 (Indicator)	03-18-15	< 61.3	< 81.8
SHWE-3 (Indicator)	03-18-15	< 60.2	< 80.4
SHWQ-6 (Control)	03-18-15	< 27.9	< 34.3

Table 5.1
Sample Type: **Milk**
Analysis: Iodine-131 and Gamma Isotopic
Units: pCi/l

Location	Collection Date	I-131	Cs-134	Cs-137	Ba-140	La-140
Required LLD →		**1**	**15**	**18**	**15**	**15**
MKE-3 (Indicator)	[1] 03-19-15	n/a	n/a	n/a	n/a	n/a
	[1] 06-11-15	n/a	n/a	n/a	n/a	n/a
	[1] 09-10-15	n/a	n/a	n/a	n/a	n/a
	[1] 12-14-15	n/a	n/a	n/a	n/a	n/a
MKA-31 (Control)	03-19-15	< 0.34	< 2.47	< 4.31	< 11.90	< 3.31
	06-11-15	< 0.23	< 2.00	< 2.65	< 11.80	< 3.76
	09-10-15	< 0.17	< 2.67	< 3.33	< 13.10	< 3.70
	12-14-15	< 0.99	< 5.53	< 5.53	< 14.30	< 6.12

[1] Sample not available. Cows not producing enough milk. See page 2 for details.

Table 6.1
Sample Type: **Fish**
Analysis: Gamma Isotopic
Units: pCi/kg (wet)

Location	Collection Date	Species	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Cs-134	Cs-137
Required LLD	→		**130**	**130**	**260**	**130**	**260**	**130**	**150**
FH-1 (Control)	10-22-15	Buffalo	< 44.0	< 36.4	< 91.9	< 19.7	< 85.0	< 50.8	< 53.7
	10-22-15	Carp	< 49.1	< 40.3	< 79.6	< 54.4	< 03.0	< 48.3	< 46.7
	10-20-15	Catfish	< 42.4	< 39.8	< 97.9	< 40.2	< 75.9	< 45.4	< 50.9
	10-22-15	Bass	< 37.9	< 37.1	< 76.7	< 34.8	< 78.6	< 30.0	< 35.5
FH-2 (Indicator)	10-20-15	Buffalo	< 68.1	< 72.3	<151.0	< 60.5	< 177.0	< 73.8	< 67.4
	10-20-15	Carp	< 44.7	< 36.5	< 75.7	< 46.7	< 103.0	< 46.8	< 44.7
	10-20-15	Catfish	< 40.8	< 38.8	< 83.9	< 44.0	< 102.0	< 40.2	< 38.4
	10-20-15	Mullet	< 76.6	< 70.9	<174.0	< 52.6	< 169.0	< 64.4	< 68.5
FH-3 (Indicator)	10-15-15	Buffalo	< 62.0	< 80.4	< 118.0	< 66.3	< 178.0	< 67.4	< 74.2
	10-15-15	Carp	< 39.5	< 30.0	< 76.6	< 48.3	< 79.4	< 30.6	< 40.5
	10-15-15	Catfish	<104.0	< 87.4	< 224.0	< 50.5	< 173.0	< 93.4	< 82.0
	10-21-15	Catfish	< 69.3	< 76.6	< 141.0	< 82.6	< 77.6	< 48.1	< 71.5
	10-15-15	Mullet	< 56.2	< 73.9	< 159.0	< 78.0	< 166.0	< 66.0	< 81.0

Table 7.1
Sample Type: **Broad Leaf Vegetation**
Analysis: Iodine-131 and Gamma Isotopic
Units: pCi/kg (wet)

Location	Collection Date	I-131	Cs-134	Cs-137
Required LLD →		**60**	**60**	**80**
BLQ-1 (Indicator)	03-18-15	< 35.9	< 18.9	< 21.6
BLQ-1 (Indicator)	06-10-15	< 38.7	< 17.2	< 17.4
BLQ-1 (Indicator)	09-09-15	< 58.7	< 37.1	< 43.2
BLQ-1 (Indicator)	12-09-15	< 46.8	< 25.7	< 27.7
BLB-1 (Indicator)	03-18-15	< 31.3	< 19.3	< 20.6
BLB-1 (Indicator)	06-10-15	< 43.8	< 19.2	< 22.8
BLB-1 (Indicator)	09-09-15	< 57.8	< 31.1	< 36.4
BLB-1 (Indicator)	12-09-15	< 54.6	< 33.8	< 37.7
BLE-20 (Control)	03-18-15	< 24.8	< 13.2	< 14.1
BLE-20 (Control)	06-10-15	< 38.0	< 18.1	< 18.4
BLE-20 (Control)	09-09-15	< 52.6	< 31.8	< 39.7
BLE-20 (Control)	12-09-15	< 54.5	< 36.4	< 32.5

Table 8.1
Sample Type: **Interlaboratory Comparison**
Analysis: Gross Beta, Iodine-131, Tritium and Gamma Isotopic
Units: pCi/kg (wet)

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Month/Year	ID Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
March 2015	E11182	Milk	I-131	pCi/L	61.3	65.1	0.94	A
			Ce-141	pCi/L	104	113	0.92	A
			Cr-51	pCi/L	265	276	0.96	A
			Cs-134	pCi/L	138	154	0.90	A
			Cs-137	pCi/L	205	207	0.99	A
			Co-58	pCi/L	178	183	0.97	A
			Mn-54	pCi/L	187	188	0.99	A
			Fe-59	pCi/L	182	177	1.03	A
			Zn-65	pCi/L	345	351	0.98	A
			Co-60	pCi/L	379	405	0.94	A
	E11184	AP	Ce-141	pCi	107	85.0	1.26	W
			Cr-51	pCi	261	224	1.17	A
			Cs-134	pCi	74.6	77.0	0.97	A
			Cs-137	pCi	99.6	102	0.98	A
			Co-58	pCi	99.8	110	0.91	A
			Mn-54	pCi	99.2	96.9	1.02	A
			Fe-59	pCi	109	119	0.92	A
			Zn-65	pCi	188	183	1.03	A
			Co-60	pCi	200	201	1.00	A
	E11183	Charcoal	I-131	pCi	82.9	85.4	0.97	A
June 2015	E11238	Milk	I-131	pCi/L	93.2	95.9	0.97	A
			Ce-141	pCi/L	Not in this	Study		
			Cr-51	pCi/L	349	276	1.26	W
			Cs-134	pCi/L	165	163	1.01	A
			Cs-137	pCi/L	143	125	1.14	A
			Co-58	pCi/L	82.0	68.4	1.20	A
			Mn-54	pCi/L	113	101	1.12	A
			Fe-59	pCi/L	184	151	1.22	W
			Zn-65	pCi/L	269	248	1.08	A
			Co-60	pCi/L	208	193	1.08	A
	E11237	AP	Ce-141	pCi	Not in this	Study		
			Cr-51	pCi	323	233	1.39	N (1)
			Cs-134	pCi	139	138	1.01	A
			Cs-137	pCi	111	106	1.05	A
			Co-58	pCi	54.0	57.8	0.93	A
			Mn-54	pCi	96.8	84.9	1.14	A
			Fe-59	pCi	162	128	1.27	W
			Zn-65	pCi	198	210	0.94	A
			Co-60	pCi	178	163	1.09	A
	E11236	Charcoal	I-131	pCi	93.9	80	1.17	A
September 2015	E11290	Milk	I-131	pCi/L	94.9	99.9	0.95	A
			Ce-141	pCi/L	228	213	1.07	A
			Cr-51	pCi/L	499	538	0.93	A
			Cs-134	pCi/L	208	212	0.98	A
			Cs-137	pCi/L	270	255	1.06	A
			Co-58	pCi/L	275	263	1.05	A
			Mn-54	pCi/L	320	290	1.10	A
			Fe-59	pCi/L	255	226	1.13	A
			Zn-65	pCi/L	392	353	1.11	A
			Co-60	pCi/L	350	330	1.06	A

Table 8.1
Sample Type: **Interlaboratory Comparison**
Analysis: Gross Beta, Iodine-131, Tritium and Gamma Isotopic
Units: pCi/kg (wet)

Month/Year	ID Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
September 2015	E11292	AP	Ce-141	pCi	104	85.1	1.22	W
			Cr-51	pCi	262	215	1.22	W
			Cs-134	pCi	86.1	84.6	1.02	A
			Cs-137	pCi	93.0	102	0.91	A
			Co-58	pCi	106	105	1.01	A
			Mn-54	pCi	117	116	1.01	A
			Fe-59	pCi	94.8	90.2	1.05	A
			Zn-65	pCi	160	141	1.13	A
			Co-60	pCi	146	132	1.11	A
	E11291	Charcoal	I-131	pCi	85.9	81.7	1.05	A
	E11294	Soil	Ce-141	pCi/Kg	209	222	0.94	A
			Cr-51	pCi/Kg	463	560	0.83	A
			Cs-134	pCi/Kg	231	221	1.05	A
			Cs-137	pCi/Kg	311	344	0.90	A
			Co-58	pCi/Kg	245	274	0.89	A
			Mn-54	pCi/Kg	297	302	0.98	A
			Fe-59	pCi/Kg	248	235	1.06	A
			Zn-65	pCi/Kg	347	368	0.94	A
			Co-60	pCi/Kg	328	344	0.95	A
December 2015	E113550	Milk	I-131	pCi/L	95.1	91.2	1.04	A
			Ce-141	pCi/L	117	129	0.91	A
			Cr-51	pCi/L	265	281	0.94	A
			Cs-134	pCi/L	153	160	0.96	A
			Cs-137	pCi/L	119	115	1.03	A
			Co-58	pCi/L	107	110	0.97	A
			Mn-54	pCi/L	153	145	1.06	A
			Fe-59	pCi/L	117	108	1.08	A
			Zn-65	pCi/L	261	248	1.05	A
			Co-60	pCi/L	212	213	1.00	A
	E11357	AP	Ce-141	pCi	89.9	84.0	1.07	A
			Cr-51	pCi	215	184	1.17	A
			Cs-134	pCi	103	105	0.98	A
			Cs-137	pCi	76.6	74.8	1.02	A
			Co-58	pCi	76.2	71.9	1.06	A
			Mn-54	pCi	91.4	94.4	0.97	A
			Fe-59	pCi	78.6	70.3	1.12	A
			Zn-65	pCi	173	162	1.07	A
			Co-60	pCi	138	139	0.99	A
	E11356	Charcoal	I-131	pCi	74.9	75.2	1.00	A

Table 8.1
Sample Type: **Interlaboratory Comparison**
Analysis: Gross Beta, Iodine-131, Tritium and Gamma Isotopic
Units: pCi/kg (wet)

Month/Year	ID Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) T8E/Analytics	Evaluation (d)
December 2015	E11353	Soil	Ce-141	pCi/kg	252	222	1.14	A
			Cr-51	pCi/kg	485	485	1.00	A
			Cs-134	pCi/kg	319	277	1.15	A
			Cs-137	pCi/kg	292	276	1.06	A
			Co-58	pCi/kg	193	190	1.02	A
			Mn-54	pCi/kg	285	250	1.03	A
			Fe-59	pCi/kg	218	186	1.17	A
			Zn-65	pCi/kg	457	429	1.07	A
			Co-60	pCi/kg	381	368	1.04	A

(1) Cr-51 has the shortest half-life and the weakest gamma energy of the mixed nuclide sample which produces a large error. Taking in account the error, the lowest value would be 119% of the known value which is considered acceptable. NCR 15-18
(a) Teledyne Brown Engineering reported result.
(b) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.
(c) Ratio of Teledyne Brown Engineering to Analytics results.
(d) Analytics evaluation based on TBE internal QC limits: A= Acceptable, reported result falls within ratio limits of 0.80-1.20. W-Acceptable with warning, reported result falls within 0.70-0.80 or 1.20-1.30. N = Not Acceptable, reported results falls outside the ratio limits of <0.70 and >1.30.

Table 8.1
Sample Type: **Interlaboratory Comparison**
Analysis: Gross Beta, Iodine-131, Tritium and Gamma Isotopic
Units: pCi/kg (wet)

DOE's MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP)
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Month/Year	ID Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Range	Evaluation (c)
March 2015	15-GrF32	AP	Gr-B	Bq/sample	0.7580	0.75	0.38 -1.13	A
	15-RdV32	Vegetation	Cs-134	Bq/sample	8.08	7.32	5.12 – 9.52	A
			Cs-137	Bq/sample	11.6	9.18	6.43 – 11.93	W
			Co-57	Bq/sample	-0.0096	False positive test		A
			Co-60	Bq/sample	6.53	5.55	3.89 – 7.22	A
			Mn-54	Bq/sample	0.0058	False positive test		A
			Zn-65	Bq/sample	-0.108	False positive test		A
September 2015	15-GrF33	AP	Gr-B	Bq/sample	1.34	1.56	0.78 – 2.34	A
	15-RdV33	Vegetation	Cs-134	Bq/sample	6.10	5.80	4.06 – 7.54	A
			Cs-137	Bq/sample	0.0002	False positive test		A
			Co-57	Bq/sample	8.01	6.62	4.63 – 8.61	W
			Co-60	Bq/sample	4.97	4.56	3.19 – 5.93	A
			Mn-54	Bq/sample	8.33	7.68	5.39 – 9.98	A
			Zn-65	Bq/sample	6.07	5.46	3.82 – 7.10	A

(a) Teledyne Brown Engineering reported result.
(b) The MAPEP known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.
(c) DOE/MAPEP evaluation: A=acceptable; W=acceptable with warning; N=not acceptable.

Table 8.1
Sample Type: **Interlaboratory Comparison**
Analysis: Gross Beta, Iodine-131, Tritium and Gamma Isotopic
Units: pCi/kg (wet)

Month/Year	ID Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Limits	Evaluation (c)
May 2015	RAD-101	Water	H-3	pCi/L	3145	3280	2770 – 3620	A
			Ba-133	pCi/L	80.6	82.5	63.9 – 90.8	A
			Cs-134	pCi/L	71.7	75.7	61.8 – 83.3	A
			Cs-137	pCi/L	187	189	170 – 210	A
			Co-60	pCi/L	85.7	84.5	76.0 – 95.3	A
			Zn-65	pCi/L	197	203	183 – 238	A
			Gr-B	pCi/L	28.8	32.9	21.3 – 40.6	A
			I-131	pCi/L	23.5	23.8	19.7 – 28.3	A
November 2015	RAD-103	Water	H-3	pCi/L	21100	21300	18700 -23400	A
			Ba-133	pCi/L	31.5	32.5	25.9 – 36.7	A
			Cs-134	pCi/L	59.65	62.3	50.6 – 68.5	A
			Cs-137	pCi/L	156	157	141 – 175	A
			Co-60	pCi/L	70.6	71.1	64.0 – 80.7	A
			Zn-65	pCi/L	145	126	113 – 149	A
			Gr-B	pCi/L	42.0	36.6	24.1 – 44.2	A
			I-131	pCi/L	24.8	26.4	21.9 – 31.0	A

(a) Teledyne Brown Engineering reported result.
(b) The ERA known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or
Volumetric measurements made during standard preparation.
(c) ERA evaluation: A=acceptable. Reported result falls within the Warning Limits. NA=not acceptable. Reported result falls outside of the Control Limit. CE=check for Error. Reported result falls within the Control Limits and outside of the Warning
Limits.

ATTACHMENT 2

Statistical Comparisons

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Statistical Analyses

- **Calculation of the Mean and Standard Deviation**

The mean and standard deviation for different groups of analyses are calculated using the following equations:

$$\overline{X} = \sum_{i=1}^{n} \frac{X_i}{n}$$

and

$$S = \left(\frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{(n-1)} \right)^{0.5}$$

where:

$\overline{X}$ = mean of sample population,
S = standard deviation of sample population,
n = number of samples in sample population, and
X_i = value of the i'th sample.

- **Comparing Two Sample Population Means**

The means of two sample populations are compared for statistical difference using the standard "t" test. The use of the test requires the assumption that the data within the populations are normally distributed and that the true standard deviations of the mean are equal for both populations. The standard "t" test tests the hypothesis that the true means of both populations are equal. The "t" value can be calculated from the equation below (obtained from the CRC Standard Mathematical Tables, 26th Edition (1981)):

$$t = \frac{\overline{X} - \overline{Y}}{\left(\frac{(n_x - 1)s_x^2 + (n_y - 1)s_y^2}{n_x + n_y - 2}\right)^{0.5}\left(\frac{1}{n_x} + \frac{1}{n_y}\right)^{0.5}}$$

where:

t = calculated "t" value,
$\overline{X}$ = mean of first data set,
$\overline{Y}$ = mean of second data set,
η_x = number of variables in first data set,
S_x = standard deviation of first data set,
η_y = number of variables in second data set, and
S_y = standard deviation of second data set.

The calculated "t" value is used to test the hypothesis that the true mean of the first population (m_x) is equal to the true mean of the second population (m_y) assuming that the true standard deviation of both populations are equal ($m_x = m_y$). The calculated "t" value is compared to a tabular "t" value such that:

a. if $t > t_{\mu,n}$ then reject the hypothesis when $m_x > m_y$,

b. if $t < -t_{\mu,n}$ then reject the hypothesis when $m_x < m_y$,

c. if $t > t_{\mu/2,n}$ then reject the hypothesis when $m_x = m_y$,

where $t_{\mu/2,n}$ and $t_{\mu,n}$ are the tabular "t" values, with a preselected error (5%), confidence level (1 - μ) or
(1- μ/2), and degrees of freedom $n = n_x + n_y - 2$. Tabular values of the "t" were obtained from the CRC Standard Mathematical Tables, 26th Edition (1981).

TABLE 2.1

STATISTICAL COMPARISON OF 2015 TLD MEASUREMENTS FROM STATIONS GROUPED BY DISTANCE			
	Stations Located 0-2 Miles from the Plant	Stations Located 2-5 Miles from the Plant	Stations Located more than 5 Miles from the Plant
Mean (mRem/std.qtr.)	11	13	12
Standard Deviation (mRem/std. qtr.)	1.46	1.03	1.43
Number in Sample	62	26	23
Calculated "t" Value (comparison of stations 0-2 and 2-5 miles from the plant to stations >5 miles from the plant)	1.32	2.71	NA*
Tabular "t" Value at 95% Confidence($t_{0.025,n}$)	1.992(a)	2.014(b)	NA*

(a) Results indicate the mean for stations located 0-2 miles from the plant are statistically identical to the mean for stations located more than 5 miles from the plant.
(b) Although the TLD stations located 2-5 miles from the plant are statistically higher than those located more than 5 miles from the plant, the quarterly doses measured in 2015 are consistent with historical data at each location as shown in Table 2.2.

* Not Applicable

TABLE 2.2

STATISTICAL COMPARISON OF 2015 TLD RADIATION DOSE TO HISTORICAL DATA BY LOCATION

Units: mrem/Std. Qtr.

Station	1990 - 2014 Avg**	1990 - 2014 Std. Dev.**	1990 - 2014 Range**		2015 Avg**	2015 Std Dev**	2015 Range**	
A-2	13	1.4	10	18	13	0.6	12	14
A-5	13	1.4	10	17	13	0.6	12	13
B-1	13	1.3	10	19	13	0.8	12	14
B-4	13	1.1	11	17	13	0.6	12	14
C-1	9	1.2	7	13	9	0.5	8	10
D-2	12	1.9	8	19	12	0.6	11	13
D-5	12	1.4	9	18	11	0.3	11	12
E-1	11	1.2	9	16	11	0.7	10	11
E-5	12	1.6	9	17	13	0.3	12	13
E-15	11	1.6	8	16	10	0.4	9	11
E-30*	11	1.5	8	17	10	0.7	9	11
F-2	12	1.1	10	17	12	0.1	12	12
F-4	14	1.4	11	19	14	0.2	14	15
F-9	12	1.3	7	17	12	0.2	12	13
G-2	14	1.8	10	19	11	0.4	11	12
G-4	11	1.2	9	16	11	0.1	11	11
G-8	12	1.9	8	19	11	0.2	11	11
H-2	13	1.3	10	18	10	0.2	10	11
H-8	12	1.2	9	17	12	1.3	11	14
J-2	12	1.5	10	17	11	0.5	10	11
J-15	13	1.2	11	17	13	0.1	13	13
K-1	11	1.2	9	16	10	0.2	10	11
L-1	13	1.4	10	16	14	0.2	14	14
M-1	12	1.5	9	18	10	0.2	10	11
N-1	13	1.5	8	18	11	0.2	10	11
P-1	10	1.2	7	15	10	0.2	9	10
P-6	14	1.3	10	19	13	0.2	13	13
Q-1	12	1.2	10	16	12	0.3	12	13
Q-5	13	2.1	9	18	13	0.2	13	13
R-1	10	1.9	6	15	9	0.1	9	10
R-6	12	2.4	8	18	10	0.2	10	10

* Control Location

** Significant outliers were removed from data sets.

PERS data indicates an average of 20 mrem for all indicator locations with a range of 11 to 33 and an average control of 18 mrem.

TABLE 2.3

STATISTICAL COMPARISON OF 2015 GROSS BETA ACTIVITY MEASUREMENTS ON AIR PARTICULATE FILTERS

SAMPLE STATION	APF-1	APQ-1	APP-1	APC-1	APE-30
Mean (10^{-3}pCi/m^3)	19	18	18	18	19
Standard Deviation (10^{-3}pCi/m^3)	4.15	3.85	3.65	4.42	4.91
Number in Sample	26	26	25	26	25
Calculated "t" Value (comparison of the indicator stations to the control station)	0.21	0.86	1.14	1.05	NA*
Tabular "t" Value at 95% Confidence($t_{0.025,n}$)	2.012(a)	2.012(a)	2.013(a)	2.012(a)	NA*

(a) Results indicate the mean for the indicator stations is statistically identical to the mean for the control station.

* Not Applicable

TABLE 2.4

STATISTICAL COMPARISON OF 2015 GROSS BETA ACTIVITY MEASUREMENTS IN DRINKING/SURFACE WATER SAMPLES			
	DWF/SWF-2	DWE/SWE-5	DWP/SWP-7
Mean (pCi/liter)	7.2	4.3	4.7
Standard Deviation (pCi/liter)	0.77	0.51	1.17
Number in Sample	4	4	4
Calculated "t" Value (comparison of the indicator stations to the control station)	3.55	0.52	NA*
Tabular "t" Value at 95% Confidence($t_{0.025,n}$)	2.447(b)	2.447(a)	NA*

(a) Results indicate the mean for the indicator station is statistically identical to the mean for the control station.

(b) Results indicate the mean for the indicator station is statistically higher than the mean for the control location. Results obtained in 2015 are consistent with historical data as stated in section 2.3.

* Not Applicable